



SBND Technical Status and Schedule

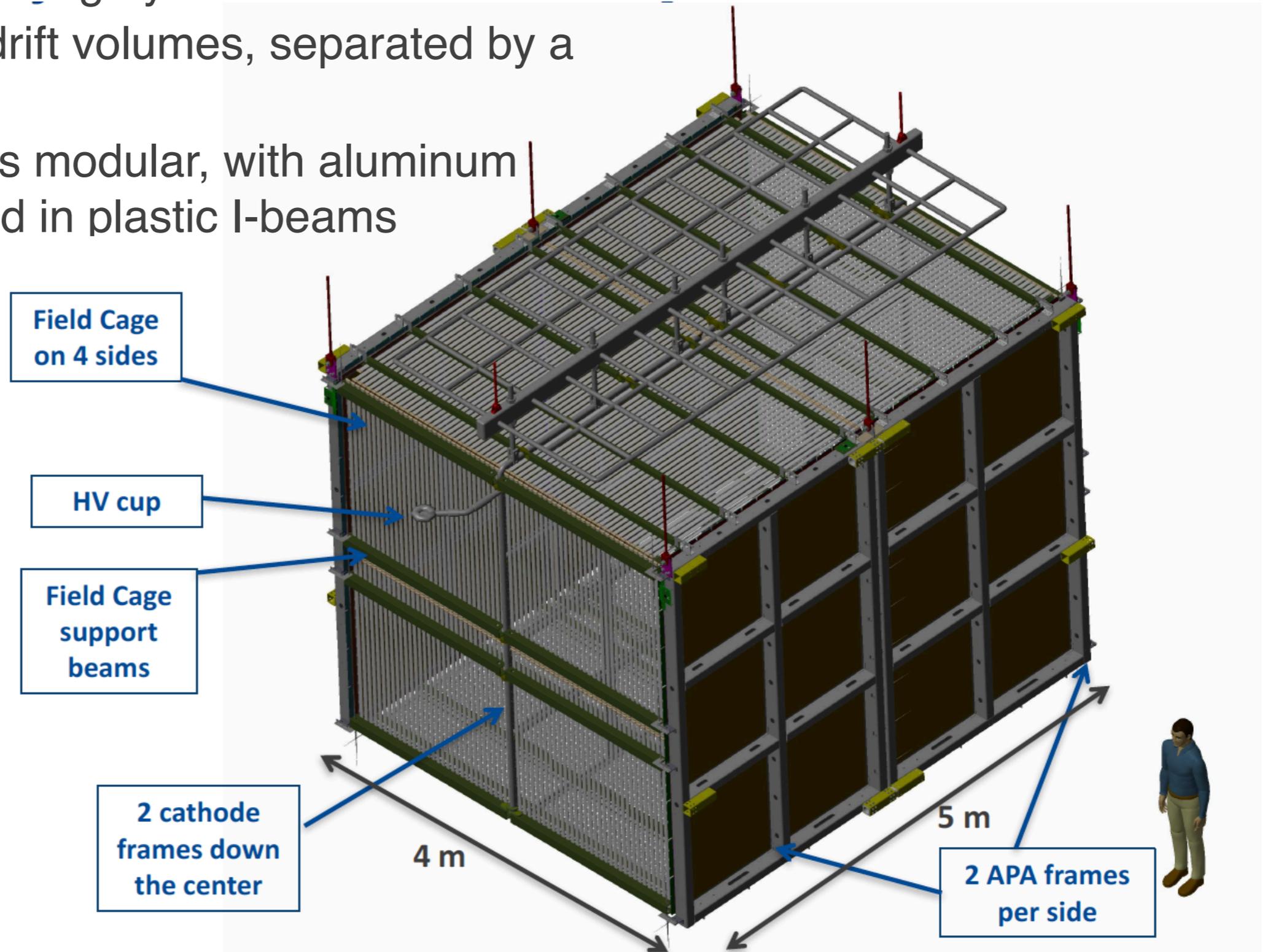
Brian Rebel
21 Sep 2018

Outline

- TPC
- Electronics
- Cryostat
- CRT/Laser
- Photon Detection
- DAQ
- Assembly and Integration
- Schedule to commissioning

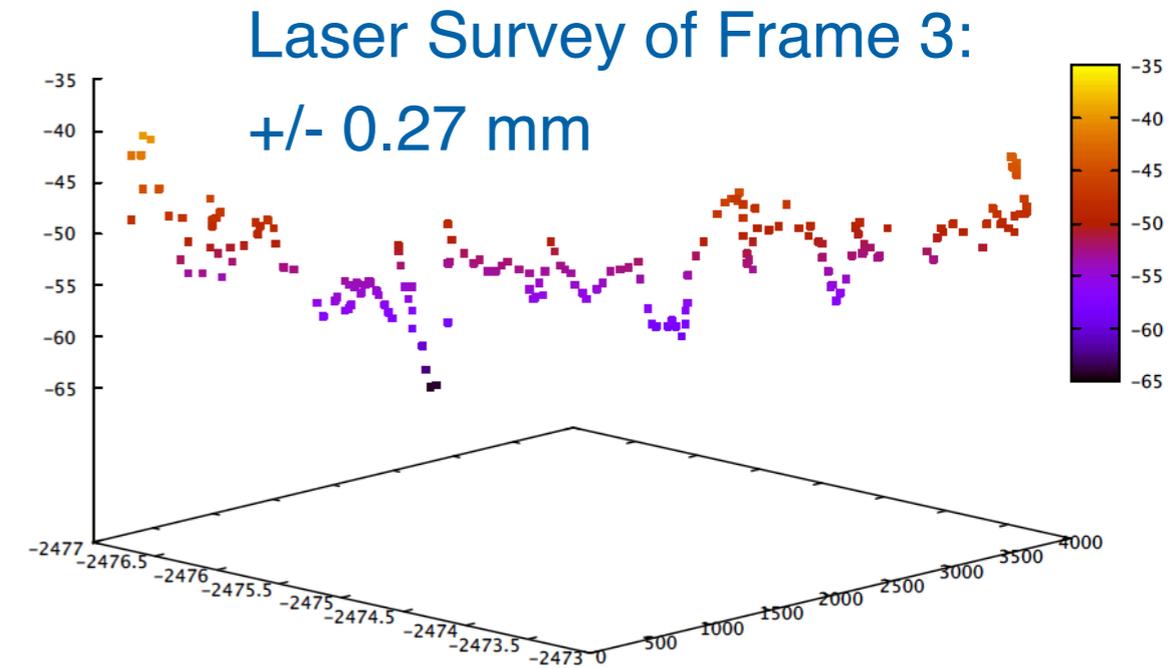
TPC

- The TPC is 5 m long by 4 m wide x 4 m tall
- There are two drift volumes, separated by a cathode plane
- The field cage is modular, with aluminum profiles mounted in plastic I-beams



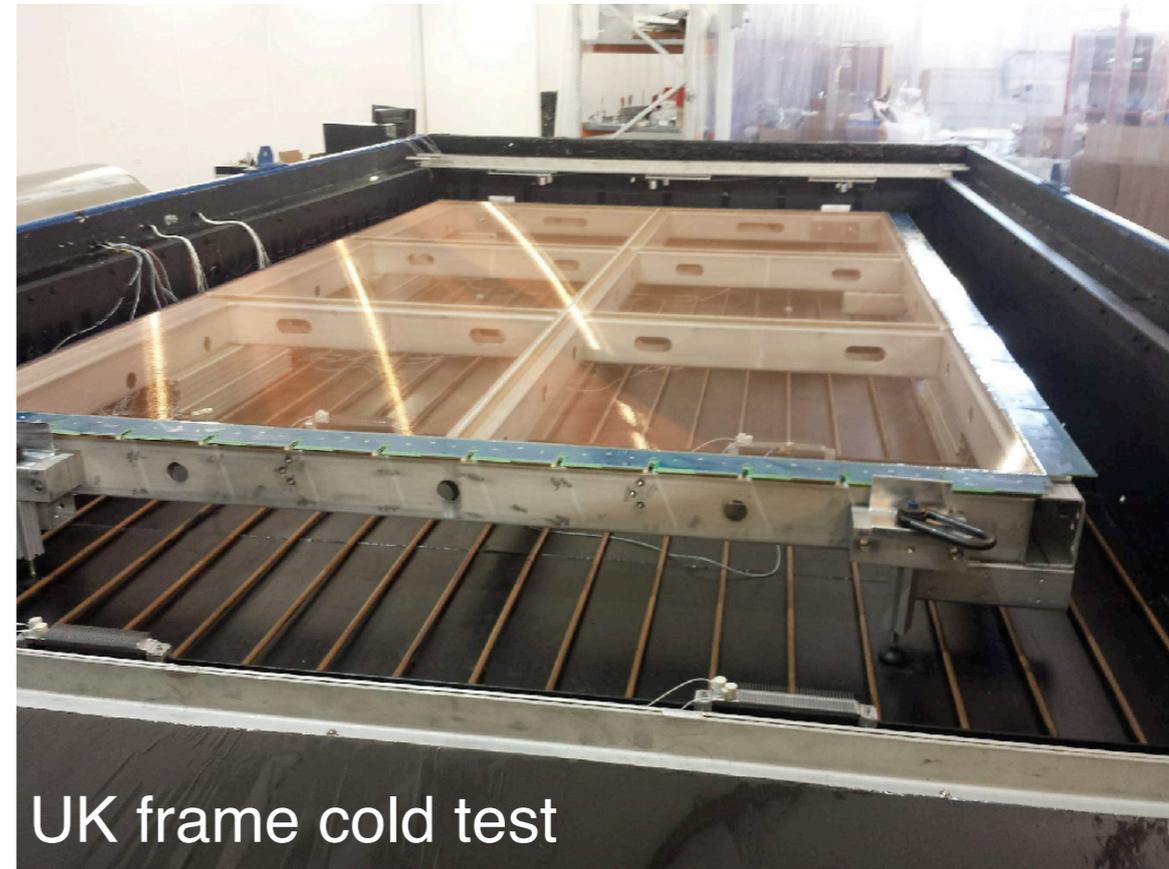
Readout Planes

- As seen on previous slide, each anode plane is made of two frames that are mechanically and electrically coupled
- Two wiring sites were established, one staffed by Manchester at Daresbury and one staffed (primarily) by Syracuse at Yale
- Frames were manufactured in the UK to be level on the front face to within 0.5 mm
- First frame was delivered in September 2017
- Both sites had production readiness reviews before they started wiring
- Also practiced wiring on smaller scale test frames before starting the production frames
- UK started wiring production frame in February 2018, US started in April 2018



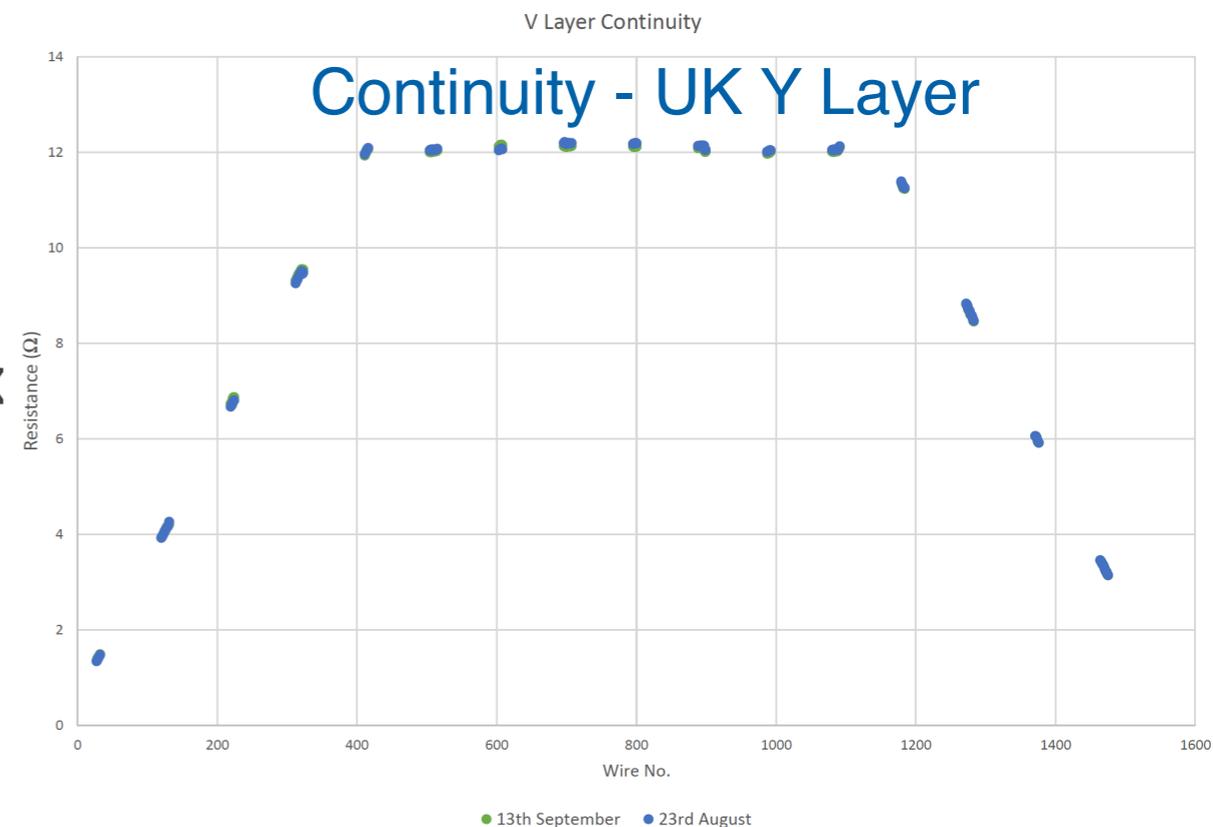
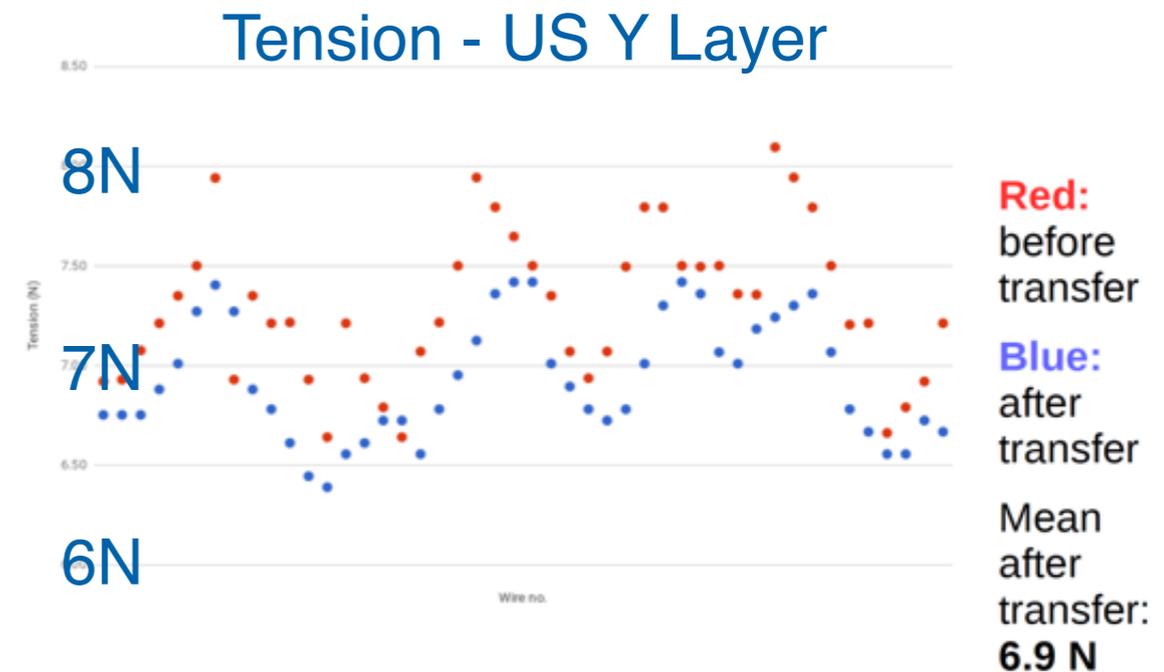
Readout Planes

- First production frames generally proceeded very well
- Both frames were completed by August 2018, a bit behind schedule but we learned a lot along the way
- US frame will be crated at Yale, then shipped to Fermilab and should arrive by November
- UK frame should be crated and shipped within the next 10 days, should arrive in October or early November



Readout Planes - Quality Control

- There are several quality checks made as each layer of wires is placed on the frame
 - Electrical continuity
 - Electrical Isolation
 - Tension
- The tension is a major concern - loose wires can induce noise as they are pushed by the argon flow
- Additionally, we observed that wires will relax after being laid on the frame, the mechanism is unclear
- Wires are required to be at 7N +/- 1N
- We tested the finished UK frame in a cold box to see if any wires broke, or if there was any change to the tension, continuity or isolation
- Cold test passed with flying colors - no damage to wires, QC checks are consistent with pre-test values
- We are satisfied that cool down will not harm the frames, no plans to test other frames



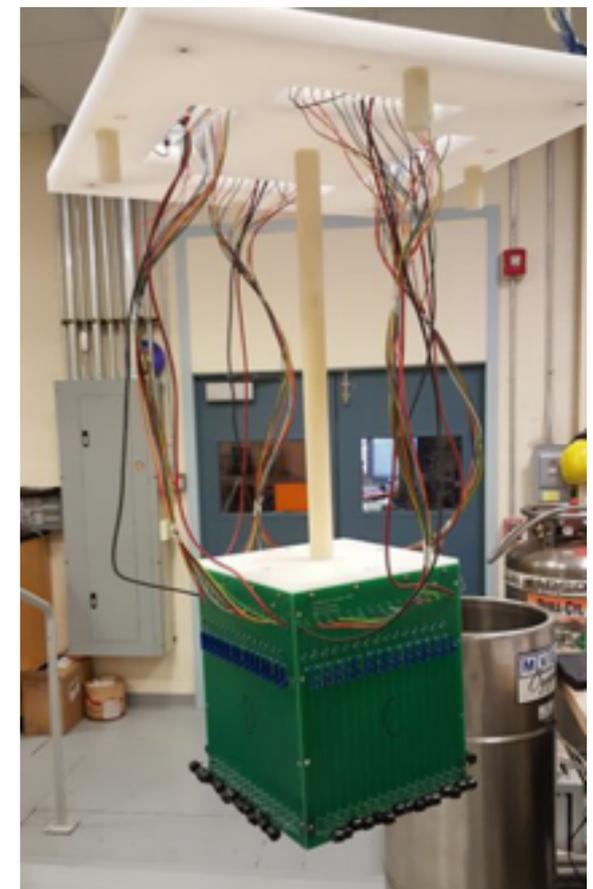
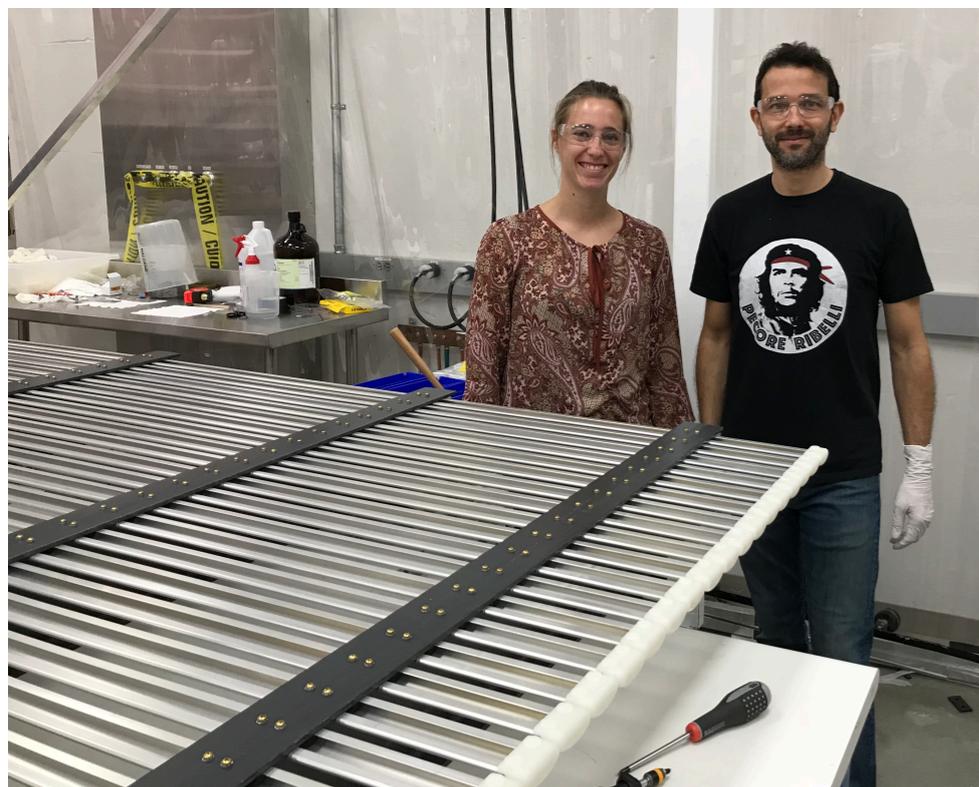
Cathode Plane



- Cathode plane consists of two frames that have 8 sub-panels each
- Each sub-panel has a stretched mesh inside
- The mesh was stretched by cooling the sub-frames with the mesh inserted but not screwed in tightly. The mesh warmed up faster than the frame, so as the frame warmed up it pulled the mesh tight
- Liverpool produced the cathode planes
- Frames are currently at Fermilab waiting to be assembled in the TPC

Field Cage

- The field cage design is very similar to the protoDUNE field cage
- The aluminum profiles were produced at the same time by the same manufacturer
- Production was done at Yale, where they also tested all the components for the resister/divider boards
- All modules are completed and ready to ship to Fermilab
- The boards will be shipped at the same time and mounted at Fermilab



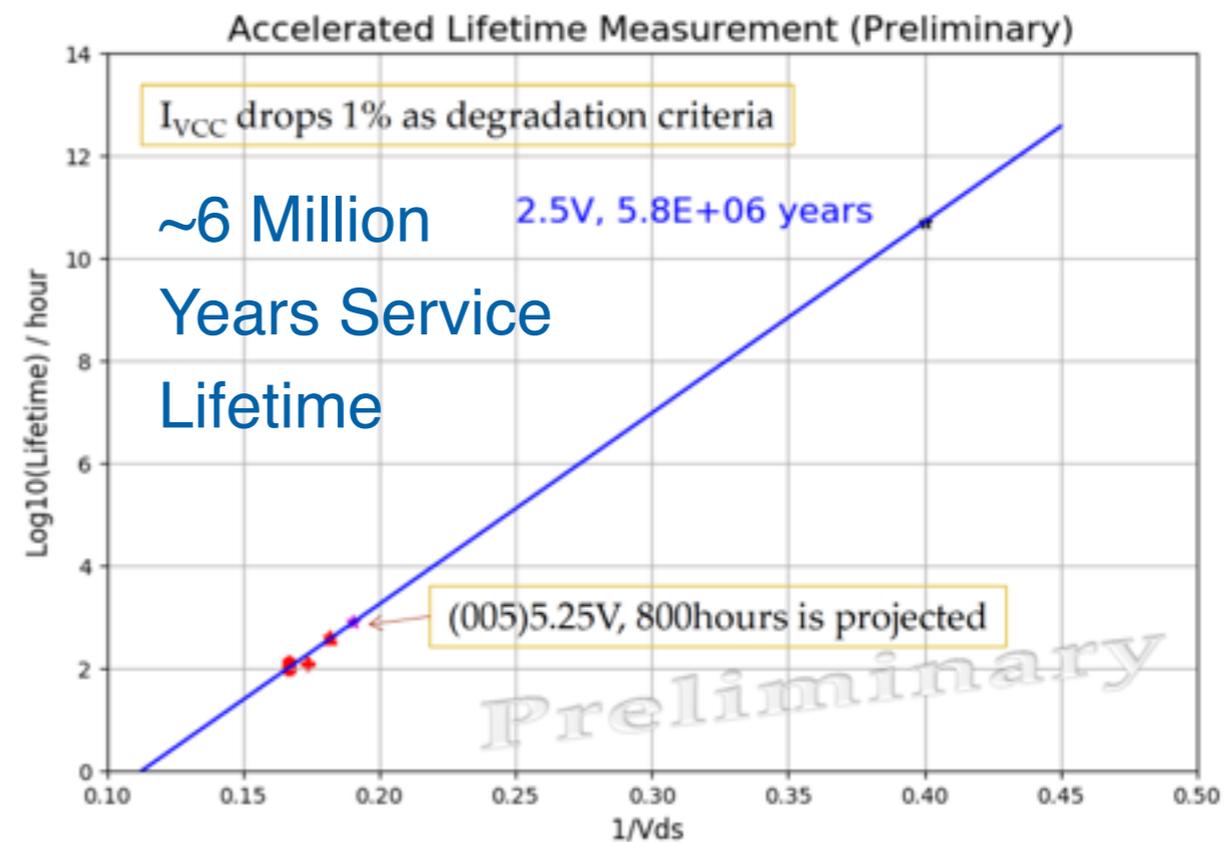
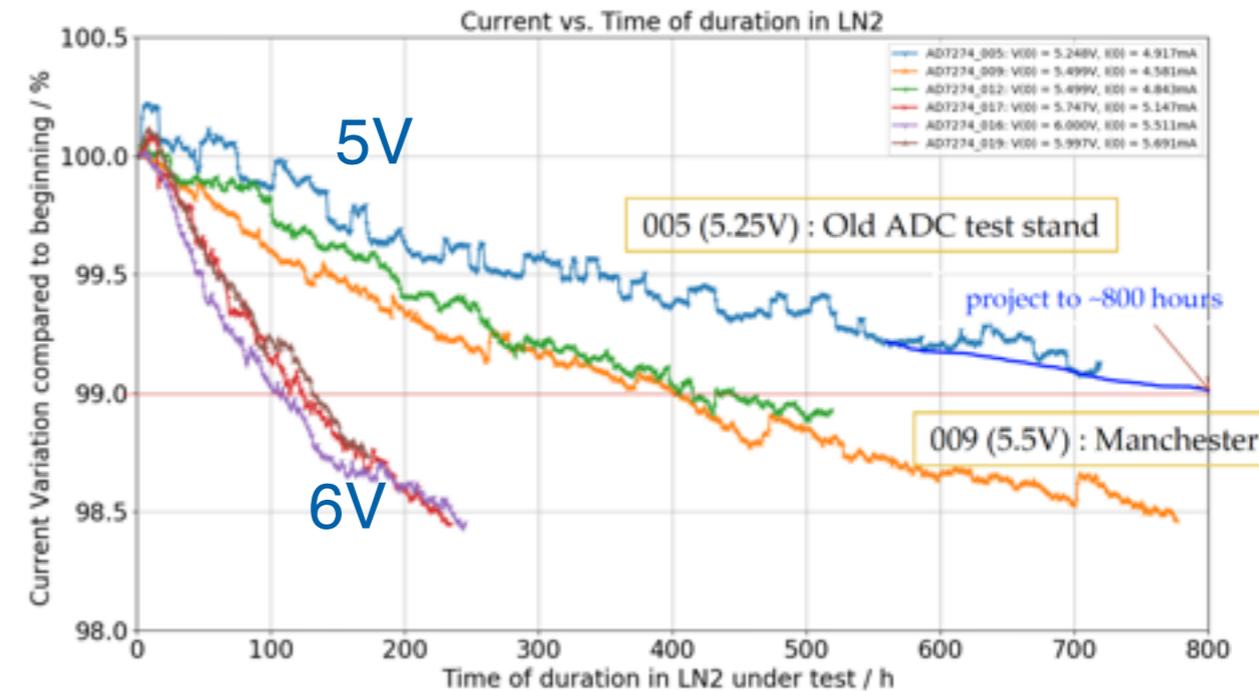
High Voltage

- There are two high voltage feedthroughs - one each from the NSF (Yale) and UK STFC (UCL)
- Yale feedthrough is based on the ICARUS design and made by CINEL
- UCL feedthrough is a modular feedthrough that could be scaled up to very long lengths
- Many parts are produced for the Yale feedthrough and final assembly was waiting on a decision about cryostat installation
- Ready to finish the Yale feedthrough now, it will be the primary feedthrough for SBND
- The feedthroughs will be tested at Yale in a repurposed cryostat from the MicroBooNE construction



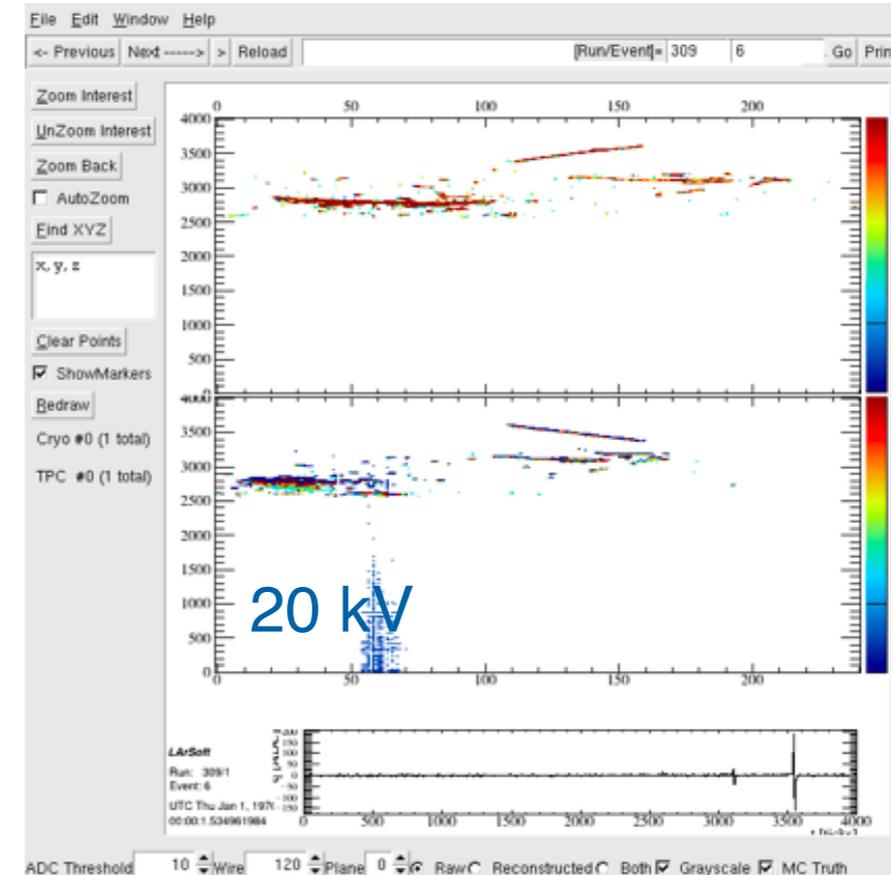
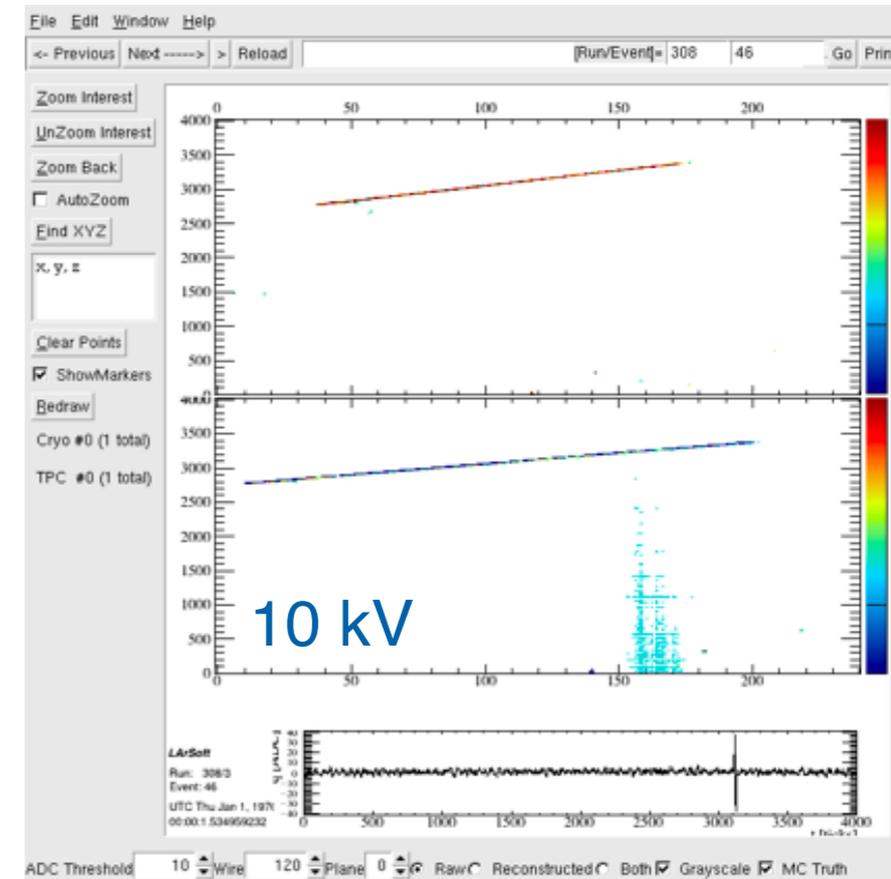
Electronics

- SBND front end ASIC and ADCs are mounted to the anode planes and are covered by the argon
- The ASICs are the same design as MicroBooNE and protoDUNE
- The initial plan was to use a similar ADC to the protoDUNE design, but that design showed flaws
- We evaluated both warm and cold ADC options
- The best cold option was to use commercially designed chips
- We stressed the chips by running them at higher voltages than intended for normal use in liquid nitrogen
- This stress should have triggered any hot carrier effect issues



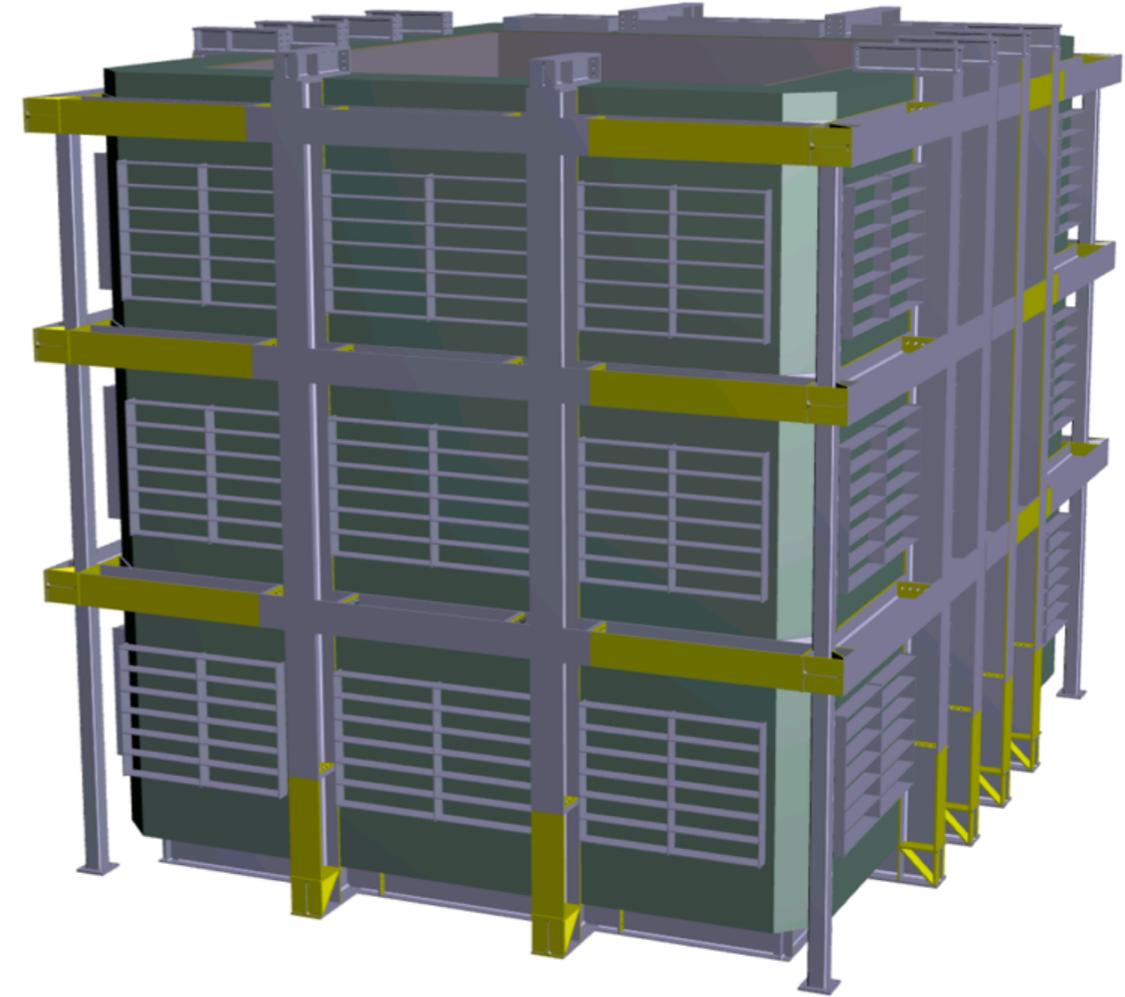
Electronics

- We produced the first prototype mother board with the commercial ADCs in January
- We also decided to perform a vertical slice test of the system from electronics to DAQ using the LArIAT cryostat and TPC
- The LArIAT environment is more challenging than the SBN ND building (grounding) or the SBND cryostat (space)
- Even so, we were able to see very nice tracks with $S/N > 30$
- We will take what we have learned from the test to make any necessary adjustments to the system design
- Will have a production readiness review in October



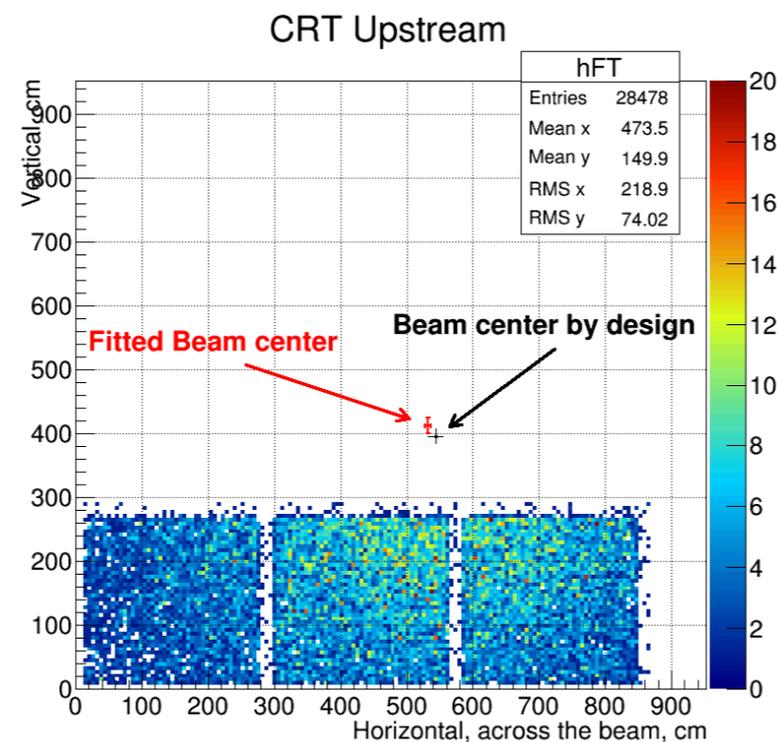
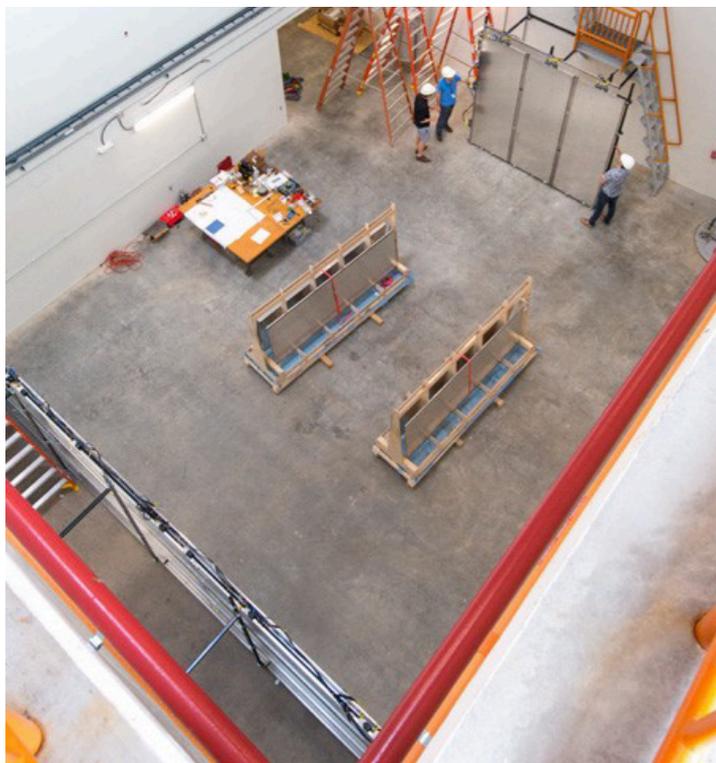
Cryostat and Cryogenics

- SBND is the final prototype of the membrane design before DUNE
- There is an agreement in principle of sharing responsibilities between DOE/FNAL, CERN and INFN
- We will be moving forward within a couple of months
- This is part of the MOU process headed by Steve Brice through the SBN collaboration
- We are moving forward with the engineering safety review of the warm vessel as recommended at the last Director's Review - CERN is updating calculations for us



Cosmic Ray Tracker and Laser

- Bern is supplying both systems
- Side CRT panel construction is complete
- 33 modules currently en route to Fermilab
- Bottom layer already at Fermilab as was used to observe the BNB in the SBND pit
- Top layer construction starts next month at Bern
- Laser heads are at Fermilab, components being produced at Bern



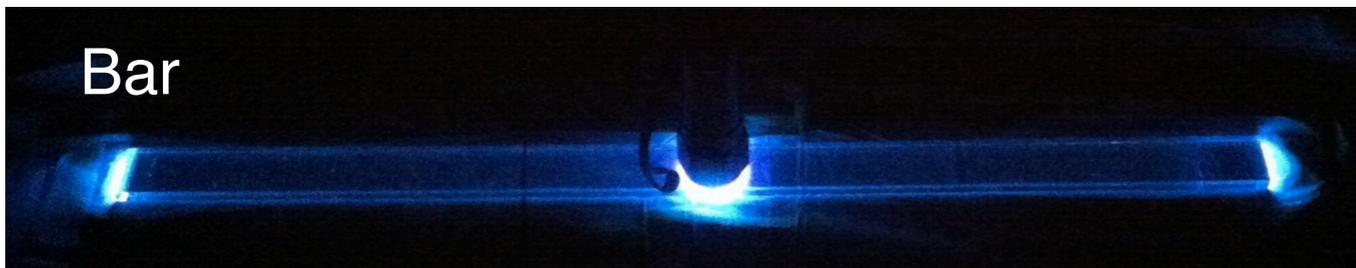
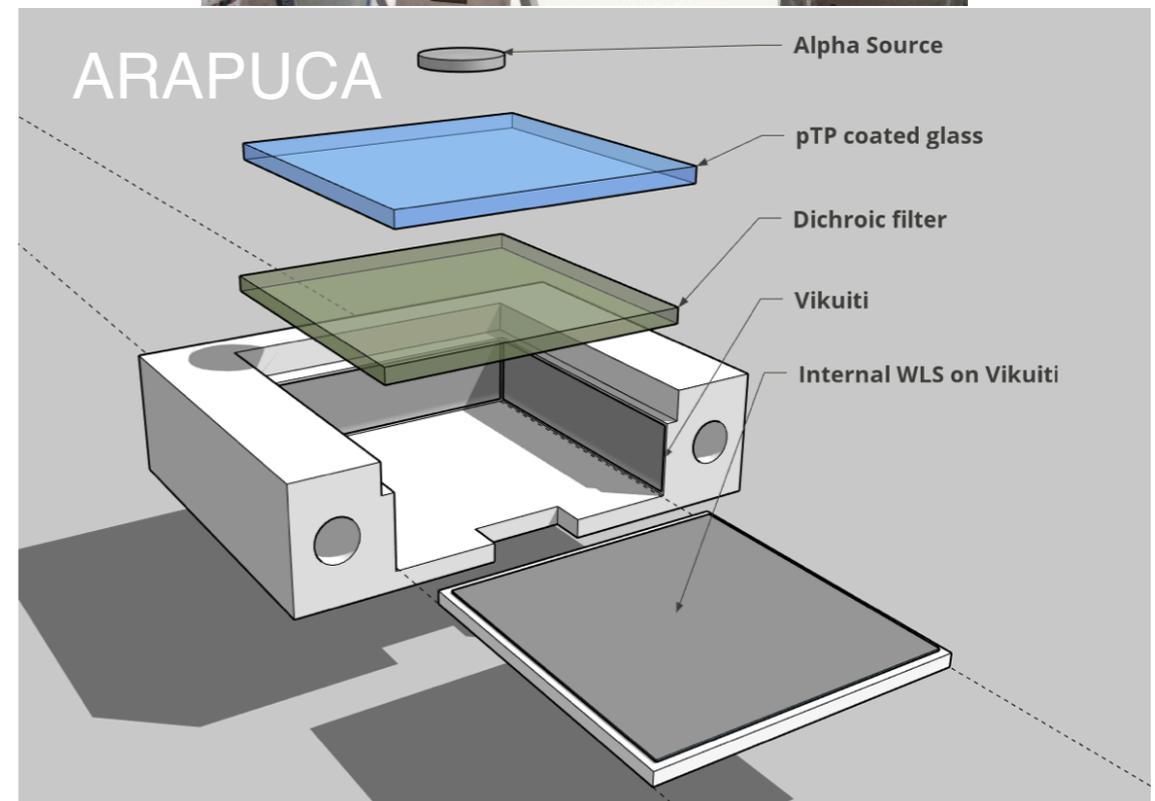
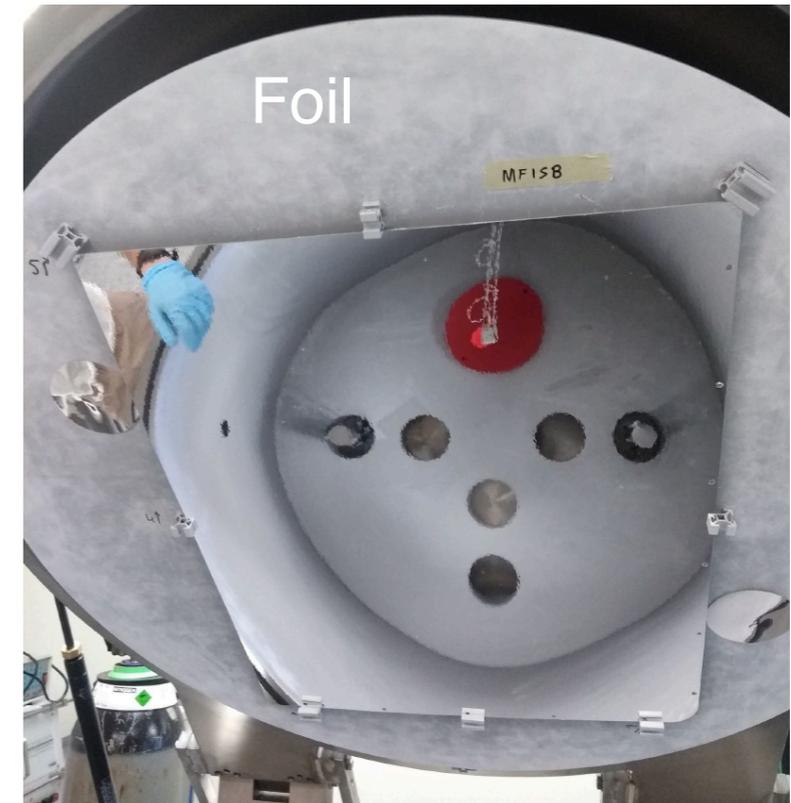
Photon Detection System - PMTs

- PMT system is a LANL contribution through their lab directed R&D program
- The PMTs and electronics are the same as in ICARUS
- 120 SBND PMTs are ready for mounting in the Coherent CAPTAIN-Mills Detector (CCM)
- Two feedthroughs are at LANL, final assembly of connectors to be done before mounting to CCM
- Electronics rack, with special cooling, is being assembled with CAEN digitizer crate and HV supply
- CCM will be ready for air testing and commissioning in early October, will run with LAr from end of October to end of December
- The 24 SBND PMT mounting boxes will be delivered by the end of September



Photon Detection System - Foils, Bars, ARAPUCAs

- SBND is a test bed for comparing new ideas in photon detection
- Manchester and UNICAMP are producing light reflecting foils to be placed between the cathode mesh
- Should improve the amount of light collected and help with energy reconstruction
- Light bar group is using acrylic bars dipped in wavelength shifter to collect photons and route them to SiPMs
- ARAPUCA group is working on possible designs that could eventually also go into DUNE
- A major benefit of this situation is that we can compare all techniques in a single detector



DAQ

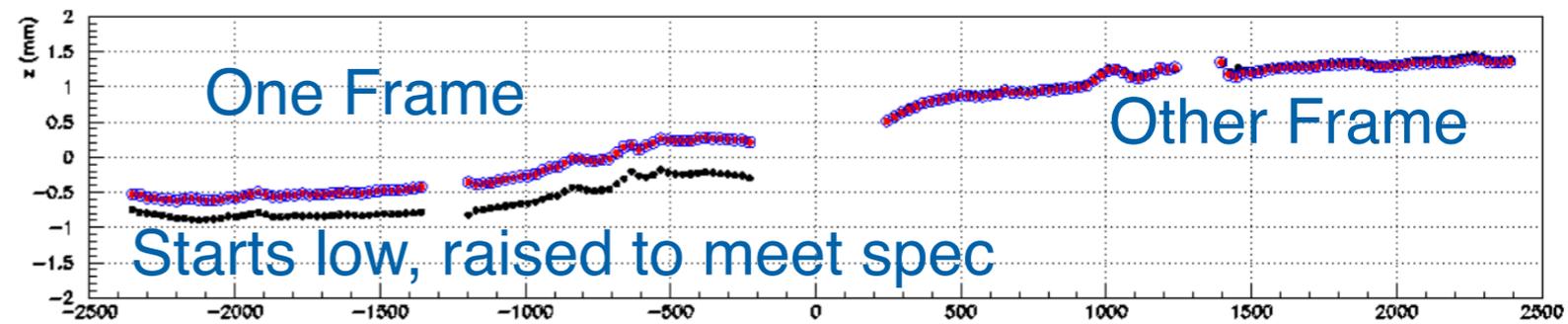
- DAQ group is working in conjunction with ICARUS for common needs
- DAQ effort has been focused on the vertical slice test
- Found and fixed several bugs in DAQ, DQM and readout chain
- Full chain of readout implemented and running
- Still things to iron out between now and start of data taking
 - Currently unable to run at a data rate of > 5 Hz
 - DAQ needs to handle crashing more gracefully
 - Occasionally there are subcomponent crashes; also sometimes have race conditions in shared memory buffers
 - Event server for DAQ has connection issues
 - Some status messages get flagged as errors
- These are great issues to find now as we have plenty of time to address them

Assembly



Results:

- Before alignment with the laser
- After adjustment - online best fit plane
- After tightening the frames with 3 M12 bolts



- The alignment facility tested with mock frames - see before and after data in right plot - met the alignment spec of < 0.5 mm at the interface
- The mock frames are not as flat as the production frames, so don't worry about the wiggles
- Working through final stages of mechanically coupling the mock frames
- Final components (lifting fixtures) for the facility are engineered and should be ready soon
- Assembly and transport frame design will have engineering safety review in October
- Will be ready when the anode frames arrive

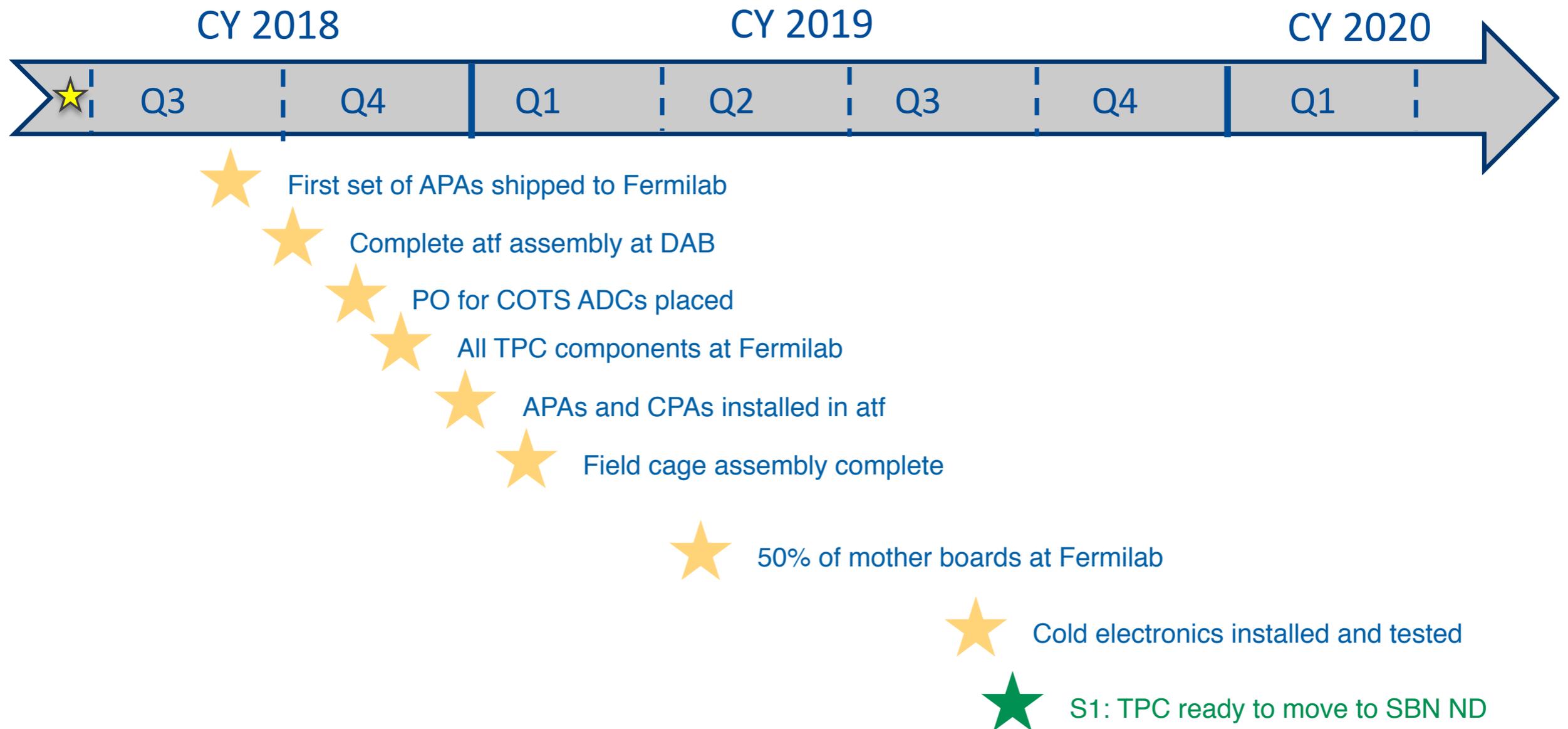
Key Milestones

- We have worked with Gina Rameika to come up with a set of key milestones for SBND
 - S1: TPC is ready to move from D0 assembly location
 - S2: Cryostat is ready to fill with liquid argon
 - S3: Cryostat is filled with liquid argon, detector is ready for commissioning
 - S4: Ready for Physics data
 - S4a: CRT bottom, sides, and lower top layer are operational
 - S4b: Shielding is in place, CRT upper top layer is operational

Managing the Schedule

- We are working to update the schedule to reflect the current state of the project and better manage the completion of construction activities and start of assembly work
- Held 3 workshops to
 - Determine the order of the work to accomplish the key milestones
 - Identify the next level of milestones leading to the key milestones
 - Logically connect the efforts across different areas
- We have discussed TPC assembly, TPC installation, and the interface of the TPC installation with the cryogenics and outfitting work
- These sessions involved the Program Coordinator, Technical Coordinators, L2s, Commissioning Coordinator and Scheduler
- Next steps
 - Assign durations, dates and costs to the tasks identified
 - Change the project file to reflect these updates and also connect the tasks with predecessors and successors
 - Planning to finish October 1, 2018

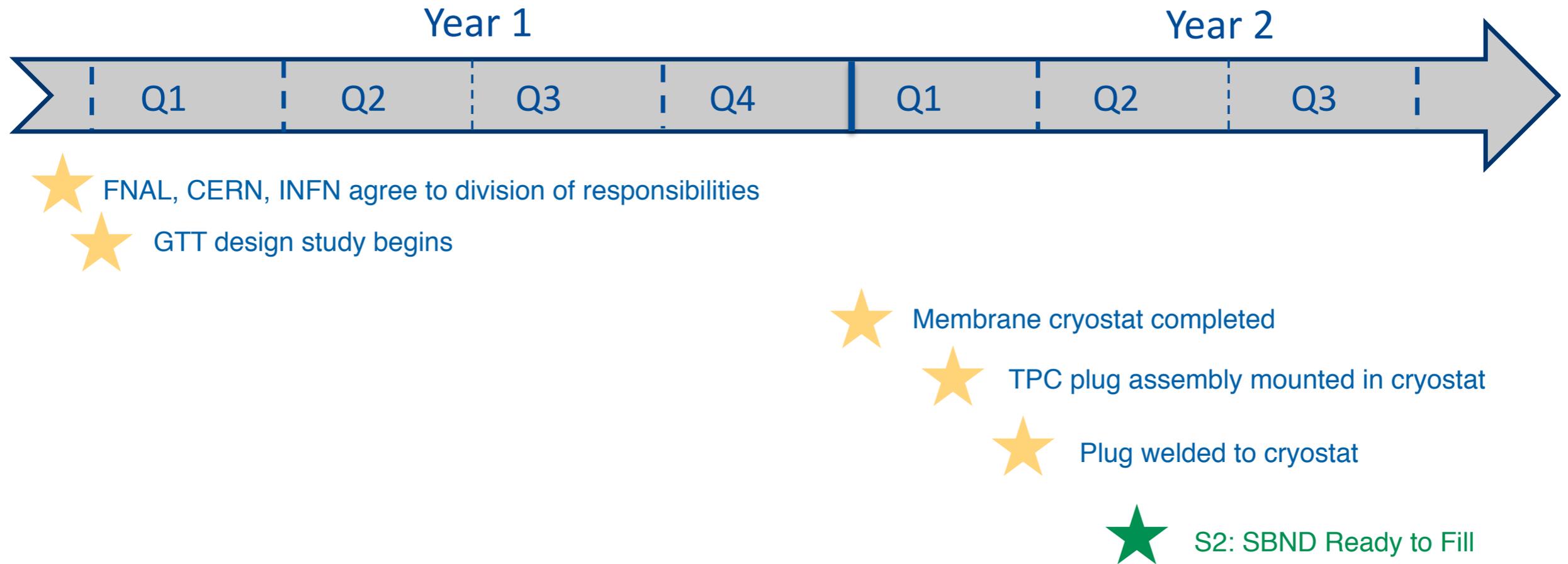
Milestones Leading To S1



Milestones Leading To S1

Milestone	Owner	Baseline	Forecast	Completed
First set of APAs shipped to Fermilab	K. Mavrokoridis	24 Sep 2018	22 Oct 2018	
PO for COTS ADCs placed	H. Chen	31 Oct 2018	15 Nov 2018	
All TPC components at Fermilab	K. Mavrokoridis	29 Nov 2018	20 Dec 2018	
Complete atf assembly at DAB	J. Zennamo	1 Feb 2019	1 Mar 2019	
APAs and CPAs installed in atf	J. Zennamo	1 Mar 2019	22 Mar 2019	
50% of motherboards at Fermilab	H. Chen	15 Mar 2019	15 Apr 2019	
Field Cage assembly complete	J. Zennamo	15 Apr 2019	15 May 2019	
Cold electronics installed and tested	H. Chen	16 Aug 2019	30 Sep 2019	
S1: TPC ready to move to SBN ND	A. Schukraft	30 Aug 2019	30 Oct 2019	

Milestones Leading To S2



Milestones Leading To S2

Milestone	Owner	Baseline	Forecast	Completed
FNAL/CERN/INFN Agree to Division of Responsibilities	B. Rebel	T0	T0	
GTT Design Study Begins	M. Nessi	T0 + 1 Month		
Membrane Cryostat Completed	M. Kim	T0 + 12 Months		
TPC Plug Assembly Mounted in Cryostat	M. Kim, J. Zennamo	T0 + 13 Months		
Plug Welded to Cryostat	M. Kim, J. Zennamo	T0 + 14 Months		
S2: SBND Ready To Fill	A. Schukraft	T0 + 16 Months		

Summary

- Full steam ahead - we are making excellent progress on all fronts and many of the components will be on their way to Fermilab soon
- The main responsibilities will soon fall on the assembly and installation group as they prepare to build the TPC
- We are on track to meet the S1 milestone for the TPC being ready to move to near detector building in 11 months
- Cryostat design work is ready to start
- Cryostat should be ready to fill with argon in 16 months - sooner if we can find ways to accelerate the schedule